



THE PICTURE BOOK AND ITS ROLE IN PRESCHOOL MATHEMATICS EDUCATION

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Abstract/Izveček

The paper examines the role of the picture book as a learning resource in preschool mathematics education and illustrates the possibilities for its application. The paper aims to examine whether preschool teachers use picture books in preschool mathematics education, what areas of mathematics they most use these for, and whether they recognize methodological advantages to their application. Results show that half of preschool teachers use the picture book as a teaching resource in preschool mathematics education, that it is mostly used to develop the concept of natural numbers and spatial relations, as well as that teachers clearly perceive methodological advantages.

Keywords:

child, picture book, preschool mathematics education, preschool teacher, speech development.

Slikanica in njena vloga v predšolskem matematičnem izobraževanju

V članku obravnavamo vlogo slikanice kot učnega vira pri učenju in poučevanju matematike v predšolskem obdobju ter predstavimo možnosti njene uporabe. Osnovni namen je ugotoviti, ali učitelji predšolske vzgoje uporabljajo slikanice pri poučevanju matematike na predšolski stopnji, za katera področja matematike jih najpogosteje uporabljajo in ali prepoznavao metodološke prednosti njihove rabe. Rezultati kažejo, da polovica učiteljev predšolske vzgoje slikanico uporablja kot učno sredstvo pri poučevanju matematike v predšolskem obdobju, da jo najpogosteje uporabljajo za razvijanje pojma naravnih števil in prostorskih odnosov ter da prepoznavao metodološke prednosti njene uporabe.

Ključne besede:

otrok, slikanica, poučevanje matematike v predšolskem obdobju, učitelj predšolske vzgoje, govorni razvoj

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Introduction

Picture books “present the first literary content to children they are given to, and the first books that mark their childhood and growing up” (Maričić et al., 2018b, 634). Perusing a picture book is pure enjoyment for a preschool child, but it is also play through which they spontaneously learn, and play is “a medium that allows imaginative transformation of the child’s observation and understanding of immediate reality” (Šagud and Petrović Sočo, 2014, 279). The crucial role in making a decision to “hang around” books is played by the illustration (picture) which depicts a phenomenon the child finds interesting. This is why the picture book is defined as a book that combines at least two codes: “linguistic (text) and visual (illustration), whereby the text is usually sparser than the visual element, and (generally) does not exceed 1800 characters” (Batić and Haramija, 2019, 246).

The methodological literature points out the importance of picture books in preschool learning, especially when it comes to the development of abstract thinking and acquisition of symbols (Petrović, 2014, 112). The role of picture books is especially evident in all activities aimed at speech and language development, vocabulary enrichment, and formation of reading habits. However, the possibilities of the picture book as a useful technique in preschool education are by no means exhausted here. This paper aims to explore and point out the contribution and value of the picture book in preschool mathematics and examine its application in practice.

Picture books’ didactic potential for preschool mathematics

Preschool mathematics education is characterized by a variety of unique properties. It is a period of mathematics education when the child should develop the first mathematical concepts and ideas, on the one hand, while on the other, facing various restrictions due to insufficiently developed logical and mathematical thinking. At this stage of development, the child’s life experience and their environment are the starting points, or the bases for building the basic mathematical concepts, i.e., “children ‘build’ them using objects, items and phenomena from the real world, bringing them into symbolic correlations by means of symbolic structures, such as speech and other written symbols” (Marendić, 2009, 135).

Developing abstract thinking is possible “only if the requirements for adequate previous sensory experiences are met” (Kopas-Vukašinović, and Stojanović, 2012, 170); hence, the teacher needs “to choose adequate and suitable examples, and nurture intuition in concept building” (Đokić and Trmčić, 2012, 184). Mathematical concepts at preschool age “cannot be learned from definition” (Đokić and Trmčić, 2012, 184).

Mathematical knowledge is woven into the very fabric of our world, and among preschool children, its acquisition must be entirely devoid of abstraction. In this context, the authors emphasise the content of children’s literature, because it is familiar and relatable to children, and can, therefore, play an intermediary role in learning mathematical concepts, because “children’s literature reveals mathematics in authentic settings that has meaning to children” (Bragg et al., 2013, 13).

In children’s literature, the picture book occupies a special place as a resource that can be used in preschool mathematics education. In fact, various research papers indicate the potential and importance arising from the application of picture books in preschool mathematics (O’Neill et al., 2004; Tucker et al., 2010; Van den Heuvel-Panhuizen, and Elia, 2012). These authors emphasize that the picture book “can offer a meaningful context for learning mathematics and provide an informal basis of experience with mathematical ideas that can be a springboard for more formal levels of understanding” (Van den Heuvel-Panhuizen et al., 2009, 37) and “can support children in attaching personal meaning to the mathematical objects involved in the books” (Van den Heuvel-Panhuizen et al., 2016, 324). These books provide children with a context to explore mathematics in a way that is relatable and relevant to their personal life (Tucker et al., 2010), as well as to improve mathematical achievement (Van den Heuvel-Panhuizen et al., 2014). They provide children with a context that allows them to learn and explore mathematics in a way that is relatable to their personal lives (Tucker et al., 2010), and motivates them to work (Can et al., 2020). In addition, research results show that the picture book “as a whole has the potential for cognitively engaging children” (Elia et al., 2010, 275).

Reading picture books can help children learn mathematics, because learning takes place in a context that is meaningful, relatable and close to their interests and preferences in life. While flipping through a picture book, the child can follow the narrative depicted through illustrations with help from the teacher or the parents, while spontaneously and unobtrusively noticing mathematical concepts that are not specifically spelled out in the narrative segment.

Picture books have “a place in math education because they often verbalize the concepts that students have difficulty understanding and show these concepts visually” (McDonald and Rasch, 2004, 9). In this context, a picture book and its content, which is represented through pictures, represent a visual code which leads to the development of a mathematical concept. The process of developing mathematical concepts is based on this code. Each mathematical concept being formed at an early age must be based on a precise visual code by means of which a certain mathematical concept is represented in an obvious way. As pointed out by Van den Heuvel-Panhuizen et al., picture books are particularly suitable because “through reading picture books, children encounter novel images or actions that linger in their minds, which they can combine with previous experiences, and on which they can build new thoughts and understandings” (Van den Heuvel-Panhuizen et al., 2009, 30-31). Preschool children do not have the capacity for abstract visualization, which they always relate to concrete items or visual representations, and in the case of picture books, it is always related to children’s spontaneous activity of leafing through a picture book and enjoying a relatable and interesting learning environment. These are the reasons why Lovitt and Clarke (1992) regard picture books as “cognitive hooks” for learning mathematics.

Picture books “can be regarded as a community agent conveying culturally developed mathematical meanings” (Van den Heuvel-Panhuizen and Elia, 2013, 228). In this way, the formal way of learning mathematics becomes redundant, because mathematics “settles” on the pages of the picture book. With the teacher’s guidance, the child notices elements in the pictures, their relationships, quantitative properties, as well as mathematical properties in the context of the picture book, thus acquiring mathematical concepts. Learning mathematics is placed in the context of the child’s interest, outside the traditional learning pattern, so children learn mathematics in a meaningful context of the story from the picture book (Columba et al., 2005). “The use of picture books in mathematics teaching gives children the opportunity to construct their learning (using similar processes as those of scientists), by attaching personal meaning to the mathematical objects involved in the books and thereby gain a mathematical understanding” (Van den Heuvel-Panhuizen and Elia, 2013, 228).

The extent to which the picture book will play a role in mathematical learning depends primarily on the choice of picture book. When choosing a picture book, one must take multiple aspects into consideration, because they can influence what the children will focus on, given that “children are selective in their learning and . . . properties of media can affect children's learning” (Strouse et al., 2018, 2). Preschool teachers must make sure that the content of the picture book matches children's interests and preferences, which vary depending on their age. The crucial element is the knowledge of integration, given that preschool mathematics education is linked to children's literature, and that mathematical knowledge and speech development are developed simultaneously.

Using picture books in preschool mathematics education

We will show how the picture book can be used in the process of developing mathematical concepts in preschool education, using concrete examples. The picture books in question were not designed specifically for learning mathematics. Studies show that picture books, even those that have not been created specifically for learning mathematics, can positively influence mathematical thinking in children, provided that they possess literary quality (Van den Heuvel-Panhuizen et al., 2016). For example, a picture book based on motifs from the famous fairy tale “Little Red Riding Hood” can be used to help children form a mental image of the concept of numbers, specifically the number ONE. Flipping through the pages of this picture book, the child notices the main characters of this fairy tale (Red Riding Hood, Grandma, the Wolf, etc.) (Crvenkapa, 2010).

Based on the context in this picture book, the entire depiction is an illustration in a picture book placed in a real context, and unit sets are formed, in other words, by using examples (one wolf, one girl, one woodcutter, one grandma), and the child arrives at an abstract concept, i.e. a mental image of the concept of the number ONE. The procedure described above allows children to be “introduced to the process of observing and identifying unit sets in their surroundings” (Maričić et al., 2018a, 406).

The picture book *Snow White and the Seven Dwarfs* can be a good basis for forming the concept of the number 7. The arrangement of the dwarfs on the pages of the book varies, and this constitutes a good basis for understanding the concept of the number 7, as the child notes the group of dwarfs.

On one page, they stand in a line, which makes them easily identifiable, whereas on another page, they are grouped with other characters; in the latter case, identifying the set of seven dwarfs becomes a more complex cognitive challenge for the child (*Snow White and the Seven Dwarfs*, 1998). Other elements featured in the illustrations for this picture book are a starting point for identifying other sets (an animal set, a set comprising Snow White and the Prince, a set of dwarf hats), knowing their cardinal numbers, and comparing numbers.

Other picture books based on well-known fairy tales can be similarly used, *The Three Little Pigs* for example (developing the concept of the number 3), or *Goldilocks and the Three Bears* (developing the concept of the numbers 3 and 4). Thanks to these examples, the child begins to view and understand numbers as quantitative properties, i.e., as a quantity of objects, instead of an abstraction, especially if we keep in mind that “the concept of numbers represents a great abstraction for children” (Maričić et al., 2018a, 405).

The picture book *The Smurf's Song* is a good starting point for developing spatial orientation, using the examples of left/right and in front of/between/behind relations (Peyo, 2009, 15–16). On the pages of the picture book, the main character, the Smurf appears in a forest environment. In the illustration, he is standing on a stone, surrounded by animals (squirrels, bears, birds, bunny, butterfly, fawn, and snails) and trees. The Smurf becomes a reference point with regard to which spatial relations are defined. Such exercises in visual perception are important in preschool mathematics, because research results have confirmed that “as growth in visual-spatial skills emerges, so does growth in math performance” (Murphy et al., 2007, 473). The teacher can use the content of such a picture book to help children form the concept of a set, and compare sets, e.g. sets of different animals (a set of squirrels; a set of birds; a set of rabbits; a set of snails), a set of Smurfs, etc.

In the picture book *Puppy*, the animal protagonist implores the child: “My favorite toy is a ball. Please, help me find it!” (Mlinarek, 2005, 4). On the page of the picture book, the animal protagonist is shown in an environment to which a child can easily relate: a room occupied by various toys, most of which are geometric shapes (a sphere, a parallelepiped, a cube, a cylinder etc.). So, the child receives a task directly from the hero of the story (puppy), thus becoming a hero himself/herself, because they need to help the puppy by identifying the ball among a range of shapes.

The teacher can expand the task by talking about other shapes that appear in the illustrations in the picture book, and in particular, by noticing and naming the differences between geometric shapes and objects.

These examples illustrate some possibilities for using picture books in preschool mathematics, and the value of this approach is evidenced by research results. In this type of learning, the child learns mathematics in the context of pictures, associating them with relatable situations from their environment, and thus creates strong links between mathematics and the context, which is crucial in preschool mathematics education. A picture book “can stimulate mathematical discussion, introduce and develop abstract concepts, and lead into relevant and interesting mathematical activities” (Jenkins, 2010, 28).

The importance of the picture book is increasingly recognized by teachers, especially “that storybook reading can be a valuable context for learning and teaching mathematics” (Anderson et al., 2004, 5). In this paper, we sought answers directly from preschool teachers’ practice regarding the use of picture books in preschool mathematics education. The research aimed to discover whether preschool teachers use picture books in their practice to develop elementary mathematical concepts, what areas of preschool mathematics are most suitable for the application of the picture book, and what methodological advantages of picture books are positively evaluated.

Methodological Framework

In this paper, we sought answers from in-service preschool teachers regarding the use of picture books in preschool mathematics education. The research aimed to determine the following: 1) whether preschool teachers use picture books in developing early mathematical concepts; 2) which areas of preschool mathematics education are most suitable for the application of picture books; and 3) which methodological advantages of picture books they evaluate positively.

The research was conducted in 2021, on a sample of 624 preschool teachers/educators working in kindergartens in Serbia. All participants took part in the first research task and answered the given question, whereas only those preschool teachers stating that they used picture books in their teaching practice provided opinions and attitudes directly related to the application of picture books and assessed the methodological benefits.

Regarding the question whether they use picture books in developing early mathematical concepts, half the preschool teachers (312 or 50%) stated that they used picture books as a resource in early mathematics education. Accordingly, the research sample was reduced to 312 participants.

The research utilized a descriptive method and theoretical analysis. A questionnaire containing close-ended questions and a Likert-type scale was constructed for the purposes of this research. The survey was anonymous to ensure impartiality of the respondents' answers. The questionnaire provided data on whether preschool teachers use picture books in the activities aimed at developing basic mathematical concepts, and the data on the elements of preschool mathematics education were developed through the use of picture books. The Likert-type scale was used to determine how preschool teachers assess the benefits of picture books in preschool mathematics education. The value of Cronbach's alpha of the questionnaire ($\alpha = 0,79$) and the Likert scale of attitudes ($\alpha = 0,82$) indicate good reliability and good internal consistency of the measuring instruments. The collected data were processed by qualitative analysis.

Research Results and Discussion

The results show that half the respondents, 312 or 50%, use picture books as a learning resource in early childhood mathematics education, while the other half does not. Although the result revealing that half the preschool teachers do not use picture books in developing early mathematical concepts is not negative in itself, it does suggest the need to explore the reasons why they do not use picture books.

We wanted to determine how preschool teachers assess the contribution of the picture book as a learning resource in mastering various concepts of preschool mathematics education. Respondents were given the task of ranking mathematical concepts by the extent to which the picture book can help develop these, from 1 (most) to 5 (least). The obtained data show that the respondents believe that the picture book is most useful in the development of the concept of *natural numbers* ($M = 1.51$), *spatial relations* ($M=2.62$), and the concept of *sets* ($M = 2.72$) (Table 1). It is notable that they place less value on the influence of the picture book when it comes to developing the concept of *measurements* ($M = 3.77$), whereas its contribution to the development of *geometry* concepts is ranked the lowest ($M = 4.33$).

Table 1: Efficiency of the picture book at helping children master mathematical concepts

Concepts in preschool mathematics education	M	SD
Sets	2.72	1.11
Numbers	1.51	.88
Geometry	4.33	.99
Measurements	3.77	1.11
Spatial relations	2.62	1.08

Such a positive assessment of the picture book's contribution to the development of the *concept of numbers* and spatial relations is understandable, because examples, i.e., situations that enable observing and identifying sets, as well as forming equivalent sets, and which represent the basis for developing the concept of numbers, are common in picture books. Likewise, spatial relations can be observed in almost every illustration by observing the relations between the elements depicted. Through such illustrations, the content of the picture book creates a realistic basis for such observations. In addition, picture books greatly facilitate the work of educators in terms of preparing learning content and providing a realistic background and the visual representations needed to develop basic mathematical concepts. It is important for us that preschool teachers recognize the role of the picture book in this process, and keep in mind that it has the potential to encourage children's thinking, because "the story provides the children with a meaningful context in which numbers play a role" (Van den Heuvel-Panhuizen and Boogaard, 2008, 352). Björklund and Palmér point out that children tend to focus on numbers related to their "cognitive, meta-cognitive, and affective factors that are present in any situation where a child encounters numbers or numerical relations" (2020, 4). Results of their research show that different forms of numerical reasoning arise while reading picture books, but that children often need the teacher's support to provide the story-driven content with a mathematical meaning (Björklund and Palmér, 2020). The explanation for the frequent use of the picture book to develop the concept of numbers lies in the fact that the concept of numbers and sets is highly abstract for preschool children, and they need a realistic content to be able to understand it, and picture books enable experiential learning (Jenkins, 2010). When it comes to developing the concept of sets, the main advantage of the picture book is that it contains realistic situations that provide a context for observing and identifying concrete examples of "natural" sets, and it is much easier to move from there to the level of abstraction with the support of teachers (Maričić & Purić, 2008, 213).

It is to be expected that the contribution of picture books to the development of geometry concepts and measurements is ranked the lowest by preschool teachers, given that the immediate reality is the main source for their learning, although there are examples in the literature claiming that the integration of literature with measurements has been applied to improve the concept of length among kindergarten children (Van den Heuvel-Panhuizen and Iliada, 2011). Storytelling context has a positive effect on learning geometry (Caseya et. al., 2008), while research results confirm that the picture book can provide a valuable experience and encourage mathematical thinking in this area (Skoumpourdi and Mpakopoulou, 2011).

The research also aimed to determine how preschool teachers assess the methodological advantages of the picture book in preschool mathematics education. The five-point Likert scale shows preschool teachers' agreement or disagreement with the methodological advantages of the picture book (see Table 2).

Table 2: Methodological advantages of the picture book in preschool mathematics education

Statement	M	SD
Picture books contribute to the acquisition of new knowledge of mathematics	1.46	.51
Picture books contribute to vocabulary enrichment and development of language skills	1.43	.63
Illustrations in the book distract the child from learning mathematics	2.34	1.07
Picture books encourage the desire to process what is experienced through different forms of expression	1.20	.49
Picture books create a realistic context for learning mathematics	1.18	.41
Picture books contribute to the development of attention, perception, memory, thinking and reasoning	1.15	.38
Picture books allow children to place abstract concepts in a familiar environment	1.61	.85
Learning mathematics through picture books helps in the formation of positive attitudes toward mathematics	1.25	.48

The results show the statement that picture books contribute to the development of *attention, perception, memory, thinking and reasoning* being ranked highest by preschool teachers ($M = 1.15$). Considering that these processes are also crucial to the process of learning mathematics, the contribution of the picture book in the development of logical-mathematical thinking is undisputable.

Undoubtedly, by giving this statement the highest ranking, preschool teachers demonstrated that they observed the picture book in the broadest sense of the word and recognize its value in overall child development.

The second-ranked statement is that *picture books create a realistic context for learning mathematics* (M = 1.18). This attitude among preschool teachers confirms the main idea of this paper and the attitudes of numerous authors who consider the picture book an important resource for learning mathematics, primarily because it creates a realistic, familiar and relatable learning context for the child (Columba et al., 2005; Maričić et al., 2018a; Maričić, et al., 2018b; Tucker et al., 2010). The next methodological advantage of the picture book appears in the statement that *picture books encourages the desire to process what is experienced through different forms of expression* (M = 1.20). It shows that educators are aware of the importance of internal motivation as the basis of learning at preschool age, which makes perfect sense. The content of the picture book is familiar and relatable to the child. The basic form of expression is a picture that encourages children to be active, inspires them to consider all elements of the situation represented in the picture, to notice relationships, to predict further actions, etc. The key role of preschool teachers here is to channel that process in the right direction, i.e., toward identifying elements that lead to the development of a certain mathematical concept. Such a high ranking of these statements confirms the attitude that teachers within “the early childhood education and mathematics education communities have increasingly recognized the potential for using storybooks and picture books to aid in children’s mathematics learning” (Flevaris and Schiff, 2014, 1).

The fourth-ranked statement is that *learning mathematics through picture books helps in the formation of positive attitudes toward mathematics* (M = 1.25). Children’s literature mediates between the child and the language code of a mathematical concept, because it helps relate personal experience to mathematical ideas (Murphy, 2000); so, the ranking of this statement shows that preschool teachers acknowledge the motivational role of the picture book as a learning resource in preschool mathematics education. The fifth-ranked statement is that *picture books contribute to vocabulary enrichment and development of language skills* (M=1.43). Although this statement refers to one of the primary functions of the picture book, its ranking shows that respondents were primarily focused on the role of the picture book in preschool mathematics education. The statements that *picture books contribute to the acquisition of new knowledge of mathematics* (M = 1.46) and that *picture books allow children to place abstract concepts in a familiar environment* (M = 1.61) received a lower ranking.

This result makes sense, given that the approach to learning mathematics should primarily be based on practical activities, and picture books provide an iconic learning environment. However, looking at the previous attitudes, it is obvious that the picture book is an important resource in preschool mathematics education. It is interesting that the statement that *illustrations in the book distract children from learning mathematics* ($M = 2.4$) was ranked very low, which once again confirms the value of picture books. Results from previous research confirm the positive effects of pictures on spontaneous mathematical cognition among children (Elia et al., 2010), so it is encouraging that preschool teachers are aware of the importance of illustrations as the picture book's visual code in preschool mathematics education.

Conclusion

A picture book – the very first book in a child's life. Leafing through it, the child plays, but at the same time, learns about the world, explores, discovers and learns. The aim of this paper was to draw attention to the picture book as a resource in the acquisition of initial mathematical knowledge, as well as in the learning and development of basic mathematical concepts, given that the results of previous research show its importance in this process. We conducted research to determine whether preschool teachers use picture books in their practice to develop basic mathematical concepts, and how they assess the role of these books and the methodological advantages in that process. The results show that half the preschool teachers use picture books and that they clearly recognize the methodological advantages of the picture book in preschool mathematics education, and its role, primarily in developing the concept of natural numbers, spatial relations and the concept of sets.

The analysis of preschool teachers' attitudes shows that the methodological advantages of picture books in developing *perception, attention, memory, thinking and reasoning* are most positively evaluated, whereas the advantage that *picture books contribute to vocabulary enrichment and development of language skills* is less positively evaluated than the previous one. This indicates that the respondents were primarily focused on the role of picture books in preschool mathematics education, though it may also be an indicator of segmentation and lack of correlation among different areas in preschool education, namely, speech development and mathematics, and a picture book is precisely the tool that connects them.

Therefore, one of the implications for future research involves determining to what extent preschool teachers are able to connect these two areas in their work.

One weakness of the present study is that it considered neither the reasons why preschool teachers omit picture books in early childhood mathematics education nor the extent to which preschool teachers are trained to use picture books for this purpose, as it may also be one of the reasons why half the preschool teachers do not use picture books. This is why we suggest future research should consider these questions, since both pre-service and in-service preschool teachers should be provided with necessary training and experience in using “children's books as an effective tool to support conceptual understanding in the mathematics teaching process” (Can et al, 2020, 99). Future research should also examine whether preschool teachers need additional education regarding this question and whether university educational programs readily accept innovations in science. The literature also stresses the importance of the need for teacher education programs to be interdisciplinary, in order to find “ways to provide literature-based mathematics experiences” (Wilburne and Napoli, 2008, 7).

It should be noted that mathematical knowledge, although highlighted in the content of the picture book, is not explicitly conveyed to children. The role of the teacher is fundamental here, i.e., to design and plan the learning process to provide clear instructions for children and guide them toward identifying elements of the picture book that lead to the formation of a mental image of the given mathematical concept. A study by Ward et al. (2017) indicates that even when it comes to mathematical picture books, one should be careful, because illustrations may distract the child toward irrelevant features. This fact implies, on the one hand, that preschool teachers should be careful when working with picture books, and on the other hand that, if appropriately presented to the child, picture books can lead to a deeper understanding of mathematical concepts and their stabilization. Numerous researchers point out that even picture books with distinctly literary content, in contrast to those focused on learning mathematics, have a role in promoting mathematical thinking among young children even without prompting by the teacher (Van den Heuvel-Panhuizen et al., 2009; Van den Heuvel-Panhuizen et al., 2016).

We must not ignore the fact that pictures “seem to attract children’s interest and attention, and due to their exciting and inspiring narrative framework, picture books are often used as pedagogical materials in preschool education” (Björklund and Palmér, 2020, 2).

Therefore, it is necessary to promote the application of picture books in preschool mathematics education. This need is motivated by several factors: children perceive the content of the picture book as reality; children show no resistance toward the picture book as a learning resource in preschool mathematics education, because it has the status of their *first book*; the variety of topics that can be covered through illustrations and text in the picture book allows the integration of mathematical concepts and other areas of knowledge; application of the picture book enables a simultaneous development of the child's vocabulary and enriches their mathematical vocabulary. These results are indicative, as preschool teachers who use picture books clearly recognize the methodological advantages of picture books in preschool mathematics education, while those preschool teachers who do not use picture books should be encouraged to use them in their work with preschool children.

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